

US Army Corps
of Engineers
Baltimore District

FLOOD RISK AND EMERGENCY ACCESS INVESTIGATION FOR BROAD RUN FARMS, LOUDOUN COUNTY, VIRGINIA



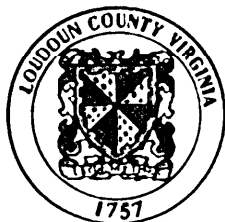
Prepared for:

Loudoun County Department of General Services
211 Gibson Street, N.W., Suite 123
Leesburg, Virginia 20176

Prepared by:

U.S. Army Corps of Engineers, Baltimore District
P.O. Box 1715
Baltimore, Maryland 21203-1715

SEPTEMBER 2005



Loudoun County, Virginia

www.loudoun.gov

Department of General Services

211 Gibson Street, NW, Leesburg, VA 20176

Phone: (703) 771-5552 Fax: (703) 737-8008

September 6, 2005

Dear Broad Run Farms Residents,

The County of Loudoun, in coordination with the U.S. Army Corps of Engineers, will conduct a Public Information meeting to explain the recently conducted study to assess the flood risk and investigate emergency access for the Broad Run Farms area. The information meeting will be held on September 29, 2005 at 7:00 PM at the Eastern Loudoun Regional Library, 21030 Whitfield Place, Sterling VA, 20164. Loudoun County and U.S. Army Corps of Engineers representatives will explain the purpose and results of the study and will be available to accept public comments and answer questions. Substantive comments will be considered for inclusion as an annex to the final report. Interested citizens are invited to attend.

The Broad Run Farms area is serviced by one road, Youngs Cliff Road (Virginia Route 811), that is low lying and subject to periodic flooding from the Potomac River. When Youngs Cliff Road is flooded, it isolates approximately 60 homes from emergency services. In addition, when the Potomac River floods, several of these homes are subject to flood damage.

The Corps of Engineers analyzed the flood event history and emergency access issues in the Broad Run Farms area to clearly define the flood risk, and developed possible solutions for alleviating the emergency access issues. The results of the investigation are at the planning level; no detailed design or construction plans will be developed as a result of this investigation. The Corps of Engineers have provided the County of Loudoun data and recommendations to aid in the planning for possible future improvements.

The draft study is available for your review before the meeting in two ways:

- **Online at the Loudoun County Website:**

Please type the link below into the Address line of your web browser. Hit **ENTER**, and you will be taken to the County Stormwater Management page. Under the first paragraph on this page is a selection list. Click on the **BROAD RUN FARMS REPORT** link and you will drop down the page to a paragraph describing the report and a second link that will take you to the folder containing the Executive Summary and the full report.

Link: <http://www.loudoun.gov/genserv/stormwater/>

- **In paper form at the Eastern Loudoun Regional Library:**

Request the Broad Run Farms Study at the Reference Desk for review within the library.

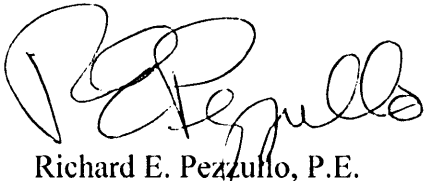
We request your input regarding your "Top 3" preferred choices among the alternatives discussed in the attached Executive Summary. Please complete and mail the attached Preferred Alternatives form to:

Loudoun County Department of General Services,
Attn: Tom Trask
211 Gibson Street, NW, Suite 123
Leesburg, VA 20176

Because we will be discussing the results of this process at the Public Information meeting on September 29th, we must receive your forms no later than September 26th, 2005.

Please address any inquiries or public comments to:

Tom Trask, (703) 737-8441, ttrask@loudoun.gov



Richard E. Pezzullo, P.E.
Deputy Director
Department of General Services
Loudoun County, Virginia

2 Atch:

- 1) Executive Summary of Report
- 2) Preferred Alternatives Response Form

**Flood Risk and Emergency Access Investigation
for Broad Run Farms
Loudoun County, Virginia**

Preferred Alternatives

Preference (Select your 1st, 2nd and 3rd choice)	Alternative Number	Description of Alternative
<hr/>	1	No Action
<hr/>	2A	Elevate Surface of Youngs Cliff Road Above 5-Year Flood
<hr/>	2B	Elevate Surface of Youngs Cliff Road Above 10-Year Flood
<hr/>	3A	Emergency Vehicle Access Road at Existing Elevation (Access Through 10-Year Flood)
<hr/>	3B	Emergency Vehicle Access Road with New Dirt/Gravel Base (Access Through 25-Year Flood)
<hr/>	4	Construct A Nature Trail/Boardwalk
<hr/>	5	Install Flood-Warning Staff Gage & Markers
<hr/>	6	Flood Preparedness/Emergency Response Plan
<hr/>	7	Emergency Response by Boat
<hr/>	8	Helicopter Rescue/MedEvac
<hr/>	9	Evacuations

We request your input regarding your "Top 3" preferred choices among the alternatives discussed in the attached Executive Summary. Please select your top choice and mark a "1" on the line next to the choice. Similarly mark your second and third choice with a "2" and "3". Please complete and mail this form to:

Loudoun County Department of General Services,
Attn: Tom Trask
211 Gibson Street, NW, Suite 123
Leesburg, VA 20176

Because we will be discussing the results of this process at the Public Information meeting on September 29th, we must receive your forms no later than September 26th, 2005.



DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1715
BALTIMORE, MARYLAND 21203-1715

REPLY TO
ATTENTION OF

August 31, 2005

Planning Division

Loudoun County Department of General Services
211 Gibson Street, N.W., Suite 123
Leesburg, Virginia 20176

Dear Sir:

The purpose of this letter is to transmit the final report for the Flood Risk and Emergency Access Investigation for Broad Run Farms, Loudoun County, Virginia, prepared by the U.S. Army Corps of Engineers, Baltimore District (Corps) under the Section 22, Planning Assistance to States Program. The report has incorporated comments from the County of Loudoun on the previous draft version.

This investigation analyzed the flood event history and emergency access issues in the Broad Run Farms area to clearly define the flood risk, and developed possible solutions for alleviating the emergency access issues. The results of the investigation, including the costs of the various alternatives, are at the planning level. No detailed design or construction plans have been developed for this study. The report provides the County of Loudoun with data and recommendations to aid in planning for future improvements at Broad Run Farms.

The Corps will attend the Public Information meeting for the residents of Broad Run Farms on September 29, 2005 at 7:00 PM at the Eastern Loudoun Regional Library, 21030 Whitfield Place, Sterling VA, 20164. During the meeting, we will present the results of the study and answer any questions. Following the meeting, the County of Loudoun will provide us any input received from the public during the meeting. This information will be included as an appendix to the final report, of which three copies will be provided to you.

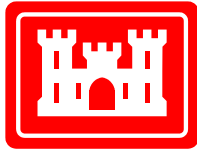
We appreciate the opportunity to work with the County of Loudoun. If you have any questions or concerns, please contact Mr. Craig Thomas at (410) 962-6095.

Sincerely,

Robert F. Gore
Chief, Planning and Environmental
Services Branch

Enclosures

FLOOD RISK AND EMERGENCY ACCESS INVESTIGATION FOR BROAD RUN FARMS, LOUDOUN COUNTY, VIRGINIA



Prepared for
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U.S. Army Corps of Engineers
Baltimore District
P.O. Box 1715
Baltimore, Maryland 21203

SEPTEMBER 2005

EXECUTIVE SUMMARY

Purpose of Study

The purpose of this study was to analyze the flood risks and emergency access issues for the portion of the Broad Run Farms residential development which is subject to flooding. Broad Run Farms is a residential development near Sterling, in the northeast corner of Loudoun County located at the confluence of Broad Run and the Potomac River. This area is subject to flooding from Broad Run and the Potomac River, and the only access road into the community, Youngs Cliff Road, is inundated by floodwaters during small flood events on Broad Run.

The results of this study are intended to provide Loudoun County and the residents of Broad Run Farms with alternatives for emergency access during a flood because Youngs Cliff Road is impassable by vehicles during high-frequency floods on Broad Run. To accomplish this, a detailed review of hydrologic and hydraulic studies was performed, and mapping of the floodplains, from the 2-year to 500-year floods, was completed. The goal was to clearly define the flood risk, in order to present solutions for emergency services access to the flood-isolated residents and structures so that Loudoun County and the residents of Broad Run Farms thoroughly understand the risk, and can develop plans for fire or medical emergency access during flooding events. This study is planning level; no detailed design or construction plans were developed. This study was performed by the Baltimore District, U.S. Army Corps of Engineers (USACE), in partnership with Loudoun County Department of General Services under the Planning Assistance to States program, authorized by Section 22 of the Water Resources Development Act of 1974 (Public Law 93-251), as amended.

Problem Description

There are fifteen major watersheds in Loudoun County, one being Broad Run. Where Broad Run joins the Potomac River in northeastern Loudoun County, the residential subdivision of Broad Run Farms, which has been in existence since the 1950's, is serviced by one road: Youngs Cliff Road (Virginia Route 811). The portion of Youngs Cliff Road along Broad Run is known to flood periodically from small storm events. When flooding occurs along this portion of the roadway, floodwaters obstruct vehicular access to residents along the Potomac River portion of Youngs Cliff Road. This not only is an inconvenience for residents, but is also a public safety concern of Loudoun County, because access is also impeded to law enforcement and fire and rescue vehicles.

Study Process

The first step of the study process was to collect and review existing data related to flood risks and topography for the study area. The Federal Emergency Management Agency (FEMA) Flood Insurance Study, and other flood studies and data were compiled. The hydrologic and hydraulic analyses of those studies were utilized with topographic mapping to produce flood boundaries for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year

flood elevations. The FEMA Flood Insurance Study and Flood Insurance Rate Maps provide flood boundaries for only the 100-year and 500-year flood events. It is important to clearly define the 100-year flood as the 1% annual chance flood, meaning that in any given year, there is a 1% chance that flood levels will reach this elevation (the base flood). To quantify the risk of a 1% annual chance flood, for a home in the 100-year floodplain, during the life of a 30-year mortgage, there is a 26% chance of experiencing a flood of this magnitude. A structure located in a low-area of the 100-year floodplain may be at risk to higher frequency floods; therefore, this study uses existing data to delineate boundaries for those floods to identify those risks. Additionally, interviews were conducted with various public officials of Loudoun County, including representatives of the Department of Building and Development, Emergency Management, the Sheriff's Office, and Sterling Fire & Rescue. Information was gathered from some local residents as well, regarding their experience with flooding in the area. The next step was to determine the extent and impacts of flooding on emergency access into Broad Run Farms, and to develop alternatives for emergency access.

Proposed Alternatives

There are several potential solutions to concerns regarding emergency access to Broad Run Farms during flooding events. Discussed below are the various solutions that have been determined to be feasible from either a technical, political, environmental, and/or economic standpoint. Note that cost estimates are planning level only. Detailed cost estimates should be conducted at or before the design phase of any construction projects.

These solutions also aim to mitigate any of the concerns expressed by the county officials and residents of Broad Run Farms. During the analysis, it was determined that for the land surface emergency access alternatives, the alternatives would be planned to allow access up to and including a 25-year flood event. For flood events larger than the 25-year flood, floodwaters are extensive and deep, thereby making surface access in most cases unrealistic.

Alternative No. 1: No Action

The No Action Alternative provides the baseline against which the other alternatives can be compared. Under this alternative, no further action would be taken in an attempt to remediate the emergency access issues along Youngs Cliff Road in Broad Run Farms. In the absence of any action, such as the alternatives subsequently mentioned, this alternative would not help provide emergency services vehicular access to respond to medical or fire emergencies along the length of Youngs Cliff Road. Emergency response, safety of emergency responders, and public safety during flood events will continue to be a concern to the county, with medical emergencies necessitating the use of boats or helicopters, lengthening response times and risking the safety of responders and the victims, as well as fire emergencies potentially being inaccessible to fire and rescue crews.

Alternative No. 2: Elevate Surface of Youngs Cliff Rd.

This alternative is to provide a solution to the impediment of emergency vehicle access along Youngs Cliff Road, and would include elevating the surface of the roadway for low portions along the roadway paralleling Broad Run. At the intersection of Broad Run Drive and Youngs Cliff Road, the road surface elevation is 208 feet. Youngs Cliff Road parallels Broad Run northward, and Youngs Cliff Road makes a sharp right turn to parallel the Potomac River. Just past this turn in the road, the elevation of the road surface also is at 208 feet. However, between these points, the road surface dips to 202 feet in one low-spot near the intersection with Broad Run Drive, and 199 feet at the second low-spot near the sewer pipeline crossing. As described in Chapter 6, during the 5-year flood event, these portions of the roadway surface overtop with up to about 1.1 feet of depth in low-spot 1, and up to about 2.3 feet of depth in the low-spot 2. In the 10-year flood event, those two same areas have up to 2.1 feet of depth, and 4.0 feet of depth over the surface of the roadway. The roadway elevation would aim to keep the existing side slope ratio of the road shoulders, which is approximately 2:1. Elevating the surface in some areas 4.0 feet would require 8.0 feet of side slope from the edge of roadway. Elevating the surface above 203 feet would require additional area for side slopes, and would also essentially build a levee which would likely increase flood levels to those residents along Broad Run and cause undue burden to those property owners. Adding 4.0 feet of depth to the surface of the roadway along a small stretch of road is feasible and would provide access during 5- and 10-year flood events; however, elevating the roadway to provide access during events producing higher than 10-year flood elevations is not feasible. Therefore, there are two options for elevating Youngs Cliff Road: elevating to allow access during the 5-year flood, and elevating to allow access during the 10-year flood. These options are discussed in more detail below. Additionally, the location of these alternatives is shown in Figure E.1.

Alternative No. 2A: Elevate Surface of Youngs Cliff Rd. above 5-year flood

To elevate the surface of the roadway along the two segments described previously to an elevation to allow access during the 5-year flood would entail reconstruction of the road surface above the 5-year flood elevation from near the intersection with Broad Run Drive running north for approximately 300 feet, and tying into roadway surface at 203 feet, then starting again about 800 feet further down the road and running for approximately 1,200 feet, tying into the 203 feet grade near the corner of the road. Portions of the roadway at or above 203 feet would not be altered, except if necessary for drainage. Costs for raising the roadway grade and resurfacing these portions of the roadway are estimated at \$273,000, which includes pavement removal, site grading, base material, and labor. Also, 30% contingency is included in this cost estimate.

Alternative No. 2B: Elevate Surface of Youngs Cliff Rd. above 10-year flood

Similar to Alternative No. 2A, this option is to elevate the surface of the roadway along the two segments described previously to an elevation to allow emergency



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Figure E.1. Alternative No. 2A and 2B

Flood Risk and Emergency Access Investigation
for Broad Run Farms, Loudoun County, Virginia

2-year Flood
5-year Flood
10-year Flood

Roads
Alternative

Parcels

Structures

0 250 500 1,000 Feet



access, in this case during the 10-year flood. This alternative would entail reconstruction of the road surface above the 10-year flood elevation from near the intersection with Broad Run Drive running north for approximately 400 feet, and tying into roadway surface at 205 feet, then starting again about 700 feet further down the road and running for approximately 2,000 feet, tying in near the corner

of the road. Portions of the roadway at or above 205 feet would not be altered, except if necessary for drainage. Costs for raising the roadway grade and resurfacing these portions of the roadway are estimated at \$1,100,000, which includes pavement removal, site grading, base material, and labor. Also, 30% contingency is included in this cost estimate.

Additionally, for both Alternatives 2A and 2B, the existing height of power poles and lines, and potential hazards associated with these power lines during flood events were considered. Due to the level of existing power poles and lines, it would be preferred that power lines be relocated underground along the roadway to reduce the risk of injury to emergency responders and residents that may be operating boats during high water events, and to reduce the need for planned power shutdowns during flood events or power outages due to high winds or limbs pulling down power lines. However, according to several reports, estimates to bury the power lines and remove the existing pole can be approximately \$1 million per mile. To service the Broad Run Farms study area with underground power lines could cost an estimated \$1.6 million for approximately 1.5 miles of power line. It suggested that Loudoun County investigate this option further, and to also investigate other options to reduce the risks associated with overhead power lines in the areas that are low-lying on Youngs Cliff Road.

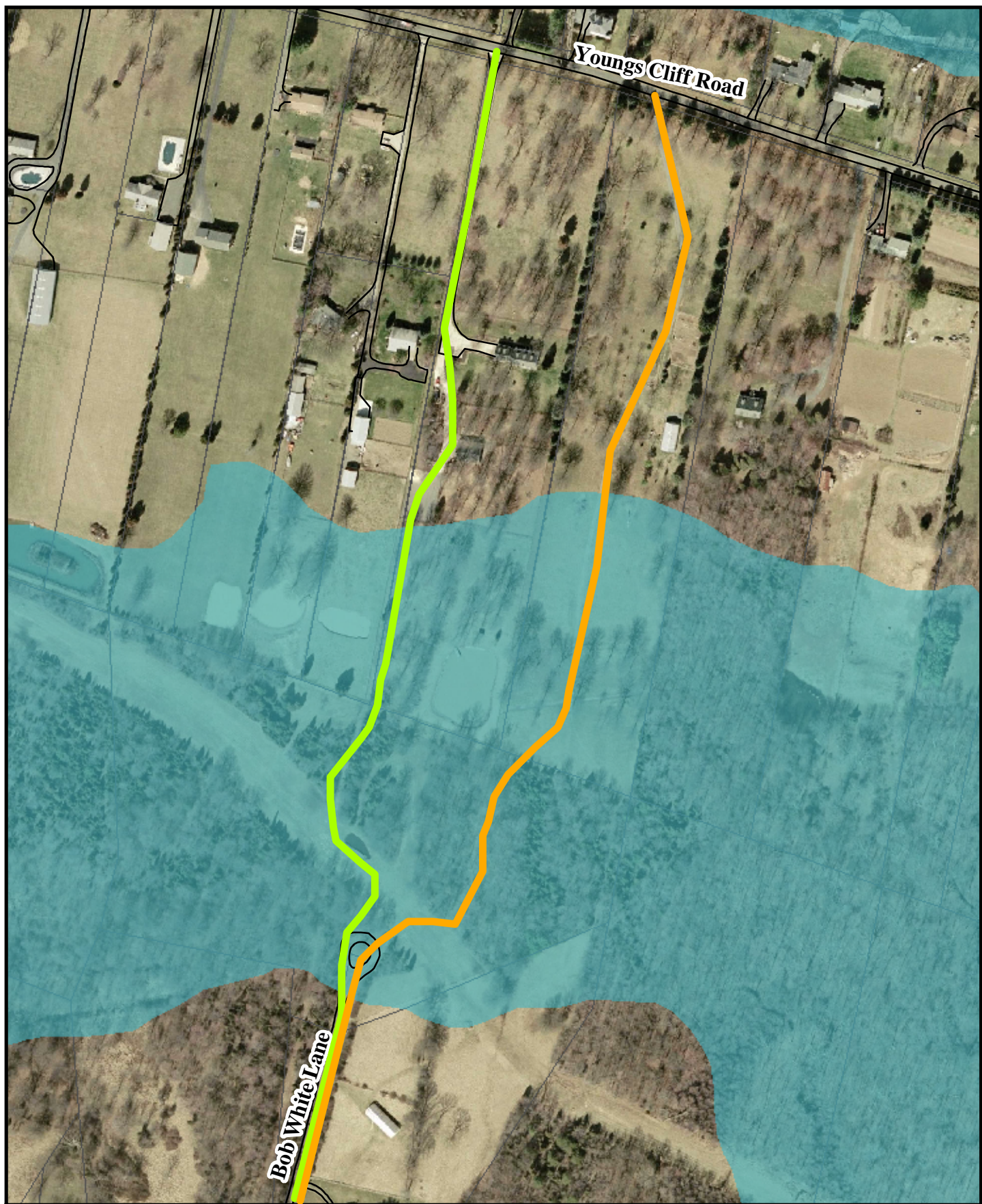
Although these alternatives would serve the purpose of access for 5- and 10-year flood events, due to high estimated costs, and negative benefits to those residences along this portion of roadway, it is not considered a preferable alternative. Additionally, Alternative No. 3 provides an alternative for access during 5-year and 10-year floods.

Alternative No. 3: Emergency Vehicle Access Road

This alternative is to provide an alternate route for emergency access to the residents along Youngs Cliff Road. This emergency vehicle access road would link from Bob White Lane northward to Youngs Cliff Road. There are two alignment options for alternatives 3A and 3B, shown in Figure E.2 as Alignment 1 and 2, and cost estimates are provided to reflect each of the alignment options. Both Alternatives 3A and 3B are contingent on the permission of the property owners on which an emergency vehicle access road would be established.

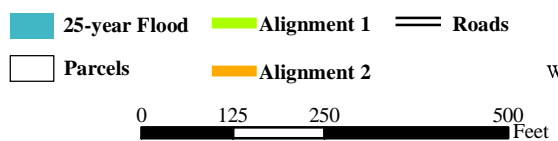
Alternative No. 3a: Emergency Vehicle Access Road - Existing Elevation (Access through 10-year flood)

This alternative provides emergency access through the 10-year flood and uses existing private drives and paths essentially as-is without the purchase of a right-



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**Figure E.2. Alternative No. 3
Proposed Alignment Options
Flood Risk and Emergency Access Investigation
for Broad Run Farms, Loudoun County, Virginia**



of-way and without construction of a roadway surface. The emergency access road would be used at the current surface elevation to provide emergency access during the 5- and 10-year events when Youngs Cliff Road is overtopped by floodwaters. It is anticipated that this alternative would require only clearing, trimming, or mowing for approximately 1,000 linear feet and 12 feet wide with low annual maintenance since it will use existing private drives and trails. The

local fire and rescue squad currently does employ 4-wheel drive emergency vehicles that would be capable of navigating the existing terrain. It is assumed that this alternative would require access control gates and/or signage at the boundaries of private property and would be posted for access for authorized emergency vehicles. This alternative would require Rights of Entry agreements with the private property owners and the LCSA, however, it is not anticipated that an easement would be required. Therefore, it is estimated that Alternative 3A would cost approximately \$10,000 (cost includes mowing and trimming, access control gates, and signs).

***Alternative No. 3b: Emergency Vehicle Access Road – Dirt/Gravel Base
(Access through 25-year flood)***

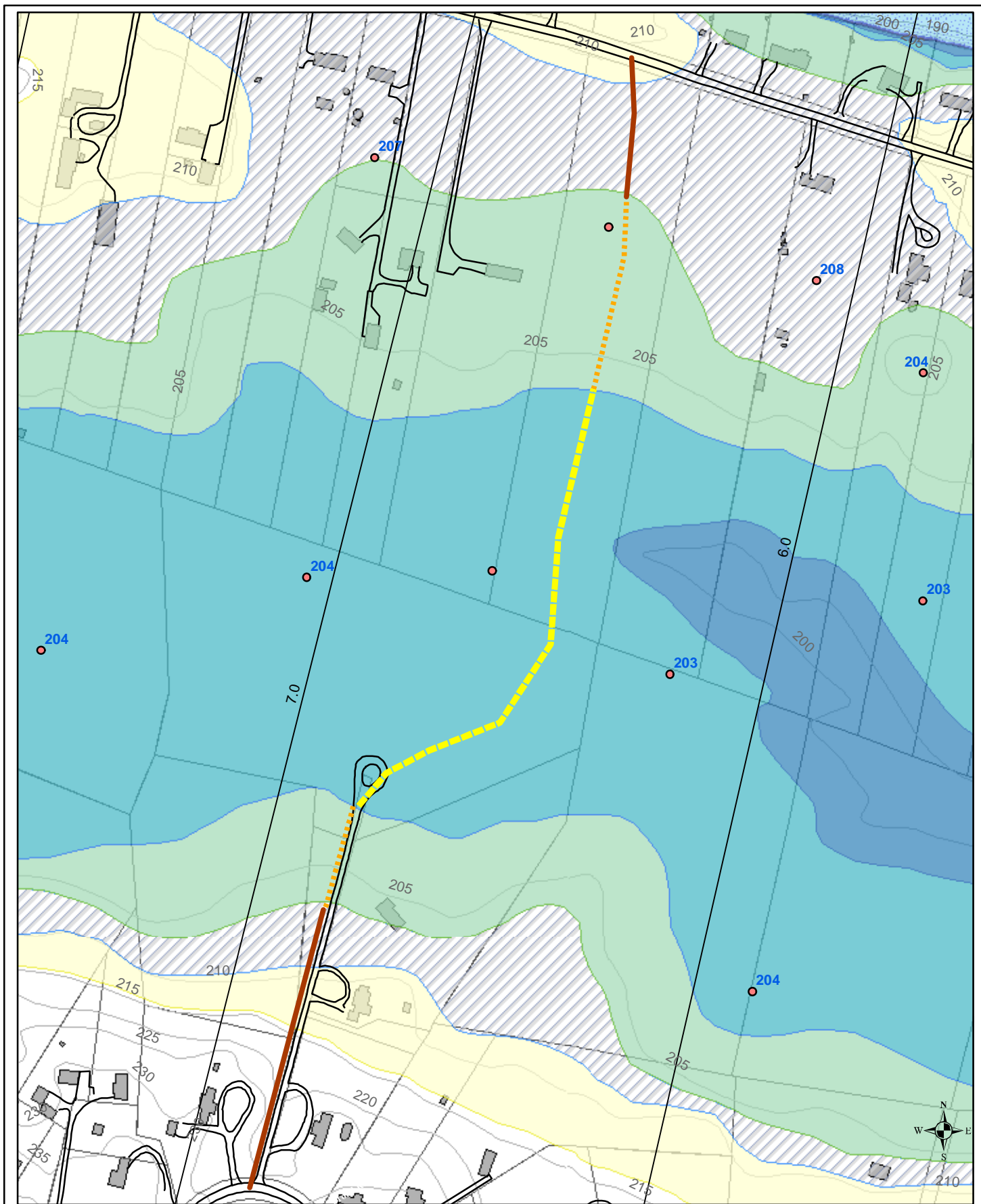
This alternative provides emergency access for floods up to and including the 25-year flood. This alternative would require approximately 1.5 feet of gravel compacted base to elevate the surface across and above the 25-year flood elevation, beginning at the cul-de-sac of Bob White Lane and running northward for about 1,200 linear feet with a width of 12 feet, following existing clearings on either alignment. Constructing a base for the road would also require culverts or pipes to reduce impacts to drainage. As with Alternative 3A, the county could secure it with gates and signage so that no unauthorized access would be permitted. Although this alternative could be used to provide an access road through the 50-year flood, it would require 3.5 feet of fill, which would require more extensive engineering analysis and may pose a safety concern for vehicles if not properly designed, therefore, the design flood is the 25-year flood. It is anticipated that environmental impacts would be moderate and wildlife movement would not be permanently impacted by the relatively low height of this access road. As with Alternative 3A, there are two alignment options, shown in Figure 7.2, which could be considered for this alternative. Alignment 1 would require construction of the roadway on existing private drives and paths, which would need to be approved by the property owner. Because of the construction and maintenance required, Alignment 1 is less favorable than Alignment 2. Although Alignment 2 could be utilized with Right of Entry agreements with the property owners as could be accomplished with Alignment 1, it is likely an easement would be purchased along Bob White Lane, across the LCSA sewer easement, and the entire parcel would be purchased. It is estimated that to construct a gravel base access road on Alignment 1 with drainage structures and gates would cost approximately \$75,000. If Alignment 2 is used requiring the purchase of an

easement and parcel the estimated cost would be approximately \$160,000 (estimates include 30% contingency).

Alternative No. 4: Nature Trail/Boardwalk

This alternative provides access during the 50-year flood event and would provide recreational use to the residents in the neighborhood. This alternative would require the construction of a nature trail/boardwalk, which will be elevated along a portion in order to be above the 50-year flood, which has an elevation in this location of approximately 207 feet. With 1 foot of freeboard, this boardwalk would be constructed at a level elevation of 208 feet. This means that for the proposed alignment, of the approximately 2,875 total linear feet for the trail, approximately 1,000 feet is outside the 50-year floodplain and would be at ground level. Additionally, approximately 750 linear feet is within the 50-year floodplain and would need to be elevated up to 3 feet from the ground surface elevation as a boardwalk. Approximately 1,125 linear feet is within the 25-year floodplain and would need to be elevated from 3 to 4 feet above the ground surface as a boardwalk. Figure E.3 shows the alignment of the trail and the segments by height from the ground surface. This alternative would require the purchase of a 10-acre parcel, using a similar path to that of Alignment 2 for Alternative No. 3. It would also require the permission or buyout of a 15 to 20 foot easement along Bob White Lane and across the Loudoun County Sanitation Authority (LCSA) easement. The portion of the nature trail at ground level would be 12 feet wide and constructed of crushed stone, or another natural substance that allows rainwater to permeate. The boardwalk would be constructed with concrete piers, and wood decking, and would be 12 feet wide and designed to carry a load minimum of 8,000 GVWR (lbs) in order to accommodate the width and weight of an Advance Life Support unit, which is a Chevrolet Suburban or similar type vehicle.

This alternative has several positive benefits in that it provides emergency access for a basic rescue unit that could then transfer the patient to a waiting ambulance at Dairy Lane, it is only used as a roadway during emergencies when Youngs Cliff Road is impassable, and at all other times serves as a recreational walkway and informative nature trail for residents who might spot deer, turkey, and other birds and wildlife. Because the portion within the 50-year floodplain is elevated on concrete piers, it will have minimal impact to the environment, current drainage patterns, or movement of wildlife. The portion across the purchased parcel would be planted with native trees and wildflowers to provide lush and interesting scenery to users of the boardwalk, provide additional habitat for wildlife, as well as provide a green buffer to the neighboring properties. Although this nature trail/boardwalk would not be able to support typical fire apparatus, it would allow smaller emergency vehicle access, also providing a benefit of increased public safety to the residents in the Broad Run Farms study area. This alternative would require the purchase of the parcel, approximately 700 linear feet of hand-select tree and brush clearing, approximately 1,000 linear feet of crushed stone trail and 1,875 linear feet of constructed boardwalk with concrete piers, and native vegetation plantings. The total estimated cost of this alternative would be approximately \$1,500,000 including 30% contingency for engineering analysis.



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Figure E.3. Alternative 4 Alignment and Segments

**Flood Risk and Emergency Access Investigation
for Broad Run Farms, Loudoun County, Virginia**

- 25-year Flood
- 50-year Flood
- 100-year Flood
- 500-year Flood

- Parcels
- Structures
- Spot Elevation
- Cross-section

- Roads
- Proposed Trail - Ground Level
- Proposed Trail - Ground to 3 ft high
- Proposed Trail - 3 ft to 4 ft high

0 50 100 200 300 400 500 Feet

Figure E.4. Example Nature Trail Accessible by Emergency Vehicle
(photo of George Washington Memorial Parkway Trail, courtesy of the National Park Service)



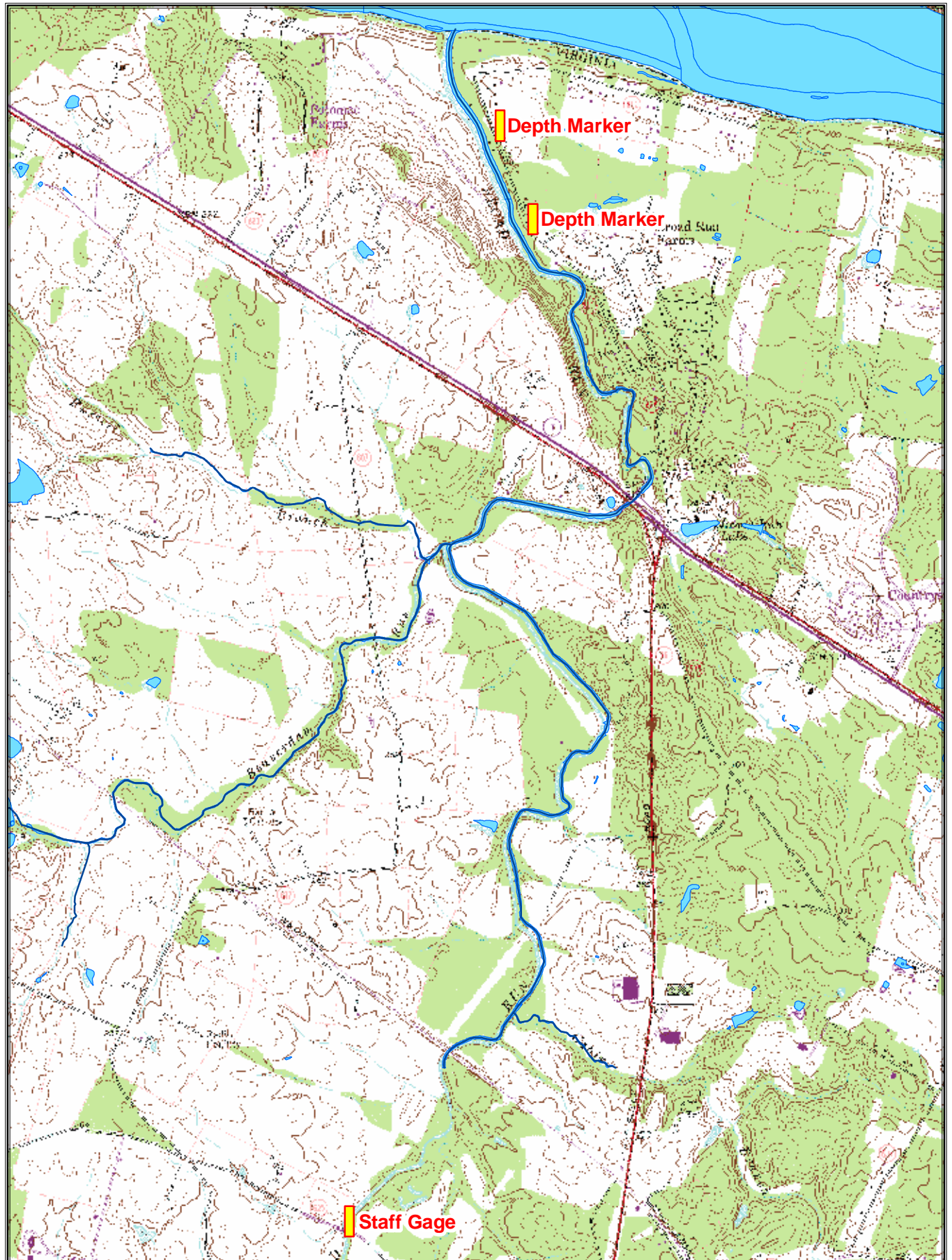
Alternative No. 5: Flood-warning Staff Gage & Markers

This alternative could be utilized alone or in conjunction with other alternatives specified in this study. A Flood Warning Staff Gage further upstream in the Broad Run watershed would serve as a local gage on Broad Run to measure and monitor water levels, which would provide additional flood warning to the high-risk residents living along Broad Run. It would also provide an indication as to when Youngs Cliff Road may become impassable, providing more opportunity to implement preparedness actions, such as sandbagging, elevating items, and/or evacuating. Staff Gages are relatively inexpensive, typically priced between \$25 and \$55 each, depending on the style, and can be mounted on anything solid in the streambed, including bridges. It is recommended that one staff gage be placed on Broad Run on the downstream side of the bridge at Waxpool Road. For easy access to view the gage, it is recommended the staff gage be placed on the eastern bridge pier, so that a County official may pull safely off Waxpool road and walk down the water pipeline easement paralleling Waxpool Road to Broad Run to read the gage. A more expensive gage that electronically transmits data can also be installed, however, in this alternative it is assumed a basic staff gage will be utilized. Figure E.5 shows the proposed location of the staff gage upstream in the Broad Run watershed, and the location of the two water-on-roadway depth markers along Youngs Cliff Road.

It is recommended that in addition to a staff gage to measure the stream level, water depth markers be set at the low-spots on Youngs Cliff Road where it typically overtops during frequent flood events. These markers should be set in concrete foundations. The depth markers on Youngs Cliff Road will provide emergency responders and residents with actual information on the depth of water over the surface of the roadway.

It is estimated that 1 staff gage at a cost of approximately \$40 can be purchased and installed by the County on the bridge pier on Waxpool road, and 2 depth markers may be purchased for approximately \$35 each and installed on the shoulder of Youngs Cliff Road. This alternative would provide only positive benefits to the emergency responders, public officials, and residents in providing valuable information to plan for flood

Figure E.5. Alternative No. 5. Proposed location of Staff Gage and Water Depth Markers



preparedness along Broad Run. There would be virtually no environmental impact in implementing this alternative. The recommended actions in this alternative are estimated to cost a total of approximately \$500.

Alternative No. 6: Flood Preparedness/Emergency Response Plan

This alternative would provide the county and the residents of Broad Run Farms with a Plan to prepare for flooding and for responding to an emergency during flood events. It would be based on the existing Standard Operating Procedures currently in place within the County, and would outline the flood risks in implementing emergency response when the Broad Run Farms area is at risk or is being impacted by flooding. Typically, a Flood Preparedness/Emergency Response Plan is developed by the community, and provides guidelines and procedures for any actions that must take place. The amount of detail depends on the needs of the users of the plan and the complexity. Due to the amount of existing information available, it is estimated that a Flood Preparedness/Emergency Response Plan for the Broad Run Farms subdivision could be developed for approximately \$10,000.

Alternative No. 7: Emergency Response by Boat

This alternative provides a means to deliver basic medical assistance to residents, but boat access does not necessarily ensure access to medical attention in the time required. Additionally, Fire & Rescue squads will only use boats on Broad Run, not on the Potomac River during floods, and only when conditions in the floodwaters do not prohibit it; therefore, when there is floating debris, extreme cold and/or ice, or when currents are very swift, rescue boats may not be available.

Beyond medical emergencies, fire risks are also a concern. In the past, under the responsibility of Ashburn Volunteer Fire Department, a pumper truck was staged at Broad Run Farms in the event of fire. Because doing this essentially takes one firetruck out of service to the rest of the area, and would require the manpower of limited volunteer resources, at this time, Sterling Fire & Rescue will not stage a fire vehicle at Broad Run Farms. Fire response by boat is not an option in Loudoun County.

This alternative is an option to provide basic medical assistance, although it would be difficult to transport a patient using a boat, therefore, for situations where a patient needs transport to a hospital, rescue using another emergency access alternative would likely be necessary. A cost is not estimated for this alternative, because the equipment and volunteer resources exist, and it cannot be estimated how often this alternative would need to be implemented.

Alternative No. 8: Helicopter Rescue / Medevac

This alternative is an option for emergencies; however, a helicopter rescue from floodwaters or for medevac would be used only when absolutely necessary. According to the Sterling Fire & Rescue Chief, the first choice for a helicopter rescue would be through the National Park Service, U.S. Park Police helicopter. However, weather

conditions, especially low-visibility and high wind conditions associated with severe storm events, will ground flights if conditions merit. Additionally, a helicopter needs a landing zone, which is usually marked by emergency vehicles, and emergency responders trained in setting up landing zones help guide the pilots to the landing zone and help the pilots avoid any obstacles, such as trees, power lines, etc. If emergency vehicles cannot be in place to mark a landing zone and responders are not on the scene to guide a pilot in, helicopter rescue may not be a viable option, without a pre-designated landing zone that is pre-evaluated by the helicopter pilots before an emergency occurs. Designating a pre-determined landing zone would need to be carefully considered and heavily coordinated with emergency management, the National Park Service, Virginia State Police, and any rescue or medevac helicopter units that could respond.

Alternative No. 9: Evacuations

During the 5-year flood, Youngs Cliff Road becomes covered with floodwaters, and during the 10-year flood, one low area in the roadway is too deep to traverse, even by a large emergency vehicle. Residents located in the 2-, 5-, and 10-year floodplains should be evacuated when floodwaters are anticipated to reach the 5-year flood or greater.

As discussed in Chapter 5 of this report, and shown in Table 5.1, a 25-year flood will impact 13 residences, and a 50-year flood will impact an additional 14, bringing the total to 27. When a flood is anticipated to produce flood levels of higher than a 50-year flood, more than half of the residences of Broad Run Farms are impacted or surrounded by floodwater, and the area of Youngs Cliff Road along the Potomac River becomes a series of islands of slightly higher ground. Note that the highest areas of ground are two small patches of land that reach an elevation of 216 ft (NGVD 29). At this point, flood waters from the Potomac River are moving very swiftly and combining with overflow from Broad Run may produce very unpredictable eddies and currents. Also at this flood level, it is expected that debris in the floodwater is prevalent. It becomes very dangerous to operate boats in these conditions, therefore, it is recommended that when a 50-year flood or higher is anticipated, evacuations be issued. At the discretion of the county Fire, Rescue, and Emergency Management department, this evacuation could be enforced as mandatory. In some instances, the Emergency Management may state that those that choose not to evacuate as ordered will be staying at their own risk. The county is prepared to open a local shelter for evacuees while floodwaters are at high levels. This alternative should be used in conjunction with the Standard Operating Procedures and/or Alternative No. 5, Flood Preparedness/Emergency Response Plan.

The map of flooding included as Figure E.6. shows the extent of flooding at and greater than the 50-year level and structures impacted.

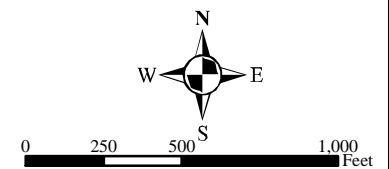
Comparison of Alternatives

In the detailed discussion of the alternatives, it is clear that some alternatives meet the objective of providing access to emergency vehicles during flood events impacting the Broad Run Farms study area. Other alternatives provide better information for preparing



US Army Corps
of Engineers
Baltimore District

**Figure E.6. 50-year and greater Floodplains
at Broad Run Farms**
**Flood Risk and Emergency Access Investigation
for Broad Run Farms, Loudoun County, Virginia**



and responding to the flooding situation. The matrix shown as Table E.1 lists the pros and cons of each alternative for comparison purposes.

Conclusion

The alternatives in this study seek to provide Loudoun County with options for ensuring the safety of the residents of Broad Run Farms during a flood event, as well as ensuring the safety of the emergency responders. Each alternative should be carefully reviewed, assessed, and considered.

Table E.1. Comparison of Alternatives Matrix

<i>Alternative</i>	<i>Description</i>	<i>Cost</i>	<i>Operation and Maintenance</i>	<i>Emergency Access Effectiveness</i>	<i>Temporary Environmental Impacts</i>	<i>Advantages</i>	<i>Disadvantages</i>
1	No Action	None	None	None	None	No cost	Does not provide any benefit of public safety during flood events
2(a)	Elevate surface of Youngs Cliff Rd to 5-year	\$273,000	Low	Low	Low	Provides access during 5-yr flood	Only provides access through 5-year flood; high cost for little benefit
2(b)	Elevate surface of Youngs Cliff Rd to 10-year	\$1,100,000	Low	Moderate	Low	Provides access through 10-yr flood	Only provides access through 10-year flood; may adversely impact residents along portion of road; high cost for little benefit
3(a)	Emergency Vehicle Access Road through 10-year	\$10,000	Low	Moderate	Low	Very minor improvements needed, utilizing existing drives	Only provides access through 10-year flood levels; contingent on private property permission
3(b) Alignment 1	Emergency Vehicle Access Road through 25-year	\$75,000	Moderate	High	Moderate	Provides access through 25-year flood; utilizes existing drives	Only provides access through 25-year flood levels; contingent on private property permission; requires moderate improvements
3(b) Alignment 2	Emergency Vehicle Access Road through 25-year	\$160,000	Moderate	High	Moderate	Provides access through 25-year flood; utilizes existing drives	Only provides access through 25-year flood levels; contingent on private property permission; requires moderate improvements
4	Construct Nature Trail Boardwalk	\$1,500,000	Moderate	High	Low	Recreational benefit to residents; provides access through 50-yr flood; low impact	Requires purchase of parcel and rights of entry; cost of construction; potentially moderate maintenance & routine inspections
5	Flood-warning Staff Gage and Markers	\$500	Low	NA	Low	Provides more data for better decision-making by County & residents; low cost	Does not provide any benefit of emergency access during flood events; requires person to read gage and distribute information
6	Flood Preparedness / Emergency Response Plan	\$10,000	Low	NA	NA	Provides a written guide and plan for flood preparedness for the County & residents	Does not provide any benefit of emergency access during flood events
7	Emergency Response by Boat	Unknown	NA	Moderate	Low	Enables emergency responders to render medical assistance to residents stranded by floodwaters and/or transport to ambulance	Potentially unsafe conditions may limit operations; lengthens response time to render assistance; difficult transport of patient
8	Helicopter Rescue / MedEvac	Unknown	NA	Low	Moderate	May be able to respond when boats cannot; provide air-transport to hospital	Limitations of weather factors; landing zone criteria; risk; potentially high cost to patient
9	Evacuations	Unknown	NA	NA	None	Eliminates risk to residents and to emergency responders	Residents have to leave properties; County must open shelter; potential increased security risks